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Study Habits and the Reading, Mathematics and Science Performance of 15-year-old Female and Male Students, PISA, 2009

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Study Habits and the Reading, Mathematics and Science Performance of 15-year-old Female and Male Students, PISA, 2009

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In 2009, the **Programme for International Student Assessment (PISA)** was implemented in Canada for the fourth time. PISA began in 2000 and focuses on the abilities of 15-year-olds in reading,[1] mathematics and science as they near the end of compulsory education, skills that are generally recognized as key outcomes of the educational process. PISA permits exploration of the ways that abilities in these areas vary across different populations and the factors that influence those differences in abilities.

As part of the student questionnaire, PISA participants were asked to indicate how much time they spent studying or doing homework each week (hereafter referred to as studying) in the three PISA subject areas: language arts, mathematics and science. Students were also asked which of 13 study methods they used and how often they used them while studying or doing schoolwork.

This article looks at the study habits of female and male 15-year-old students in 2009 and how various approaches to the completion of schoolwork are associated with differences in PISA scores. The purpose of the following analysis is to examine what works, and for whom, when 15-year-old students study and complete their schoolwork.

Hours invested in studying and doing homework

Students who spent three hours or more per week studying in each of the three school subjects included in the PISA assessment had consistently higher PISA scores in those subjects than those who invested less than three hours per week. There was a statistically significant increase in the PISA average scores for female students in reading, mathematics and science and in mathematics and science average scores for male students. The improvements in PISA scores ranged from 15 points for males in science to a high of 27 points for females in mathematics. There was no significant difference for males in reading (Table 1).

Table 1
Average PISA scores by hours spent per week studying or doing homework, by selected school subjects and by sex, Canada, 2009

Subject of study or homework	Number of hours spent per week studying/doing homework in each subject		Difference in average score
	Less than three hours	Three hours or more	
	average PISA score		number
Both sexes			
Language arts (PISA reading)[1]	524	541	17*
Mathematics	524	545	21*
Science	528	547	19*
Females			
Language arts (PISA reading)[1]	539	563	24*
Mathematics	514	541	27*
Science	523	547	24*
Males			
Language arts (PISA reading)[1]	510	512	2
Mathematics	532	550	18*
Science	532	547	15*

***** indicates a significant difference in PISA scores between those who studied less than three hours and those who studied three hours or more for each subject.
1 Students were asked how much time they spent studying or doing homework in the language arts which includes literature, grammar, vocabulary, spelling, and writing, while the PISA test assessments were on reading literacy. The homework hours indicated in the table reflect study time in the language arts while the average scores reflect average performance on the PISA reading assessment.
Source:Programme for International Student Assessment, OECD, 2009.

Box 1:
Understanding PISA scores

PISA scores for reading, mathematics and science are standardized across all Organisation for Economic Co-operation and Development (OECD) countries. They are expressed on a scale which has an overall average score of 500 points for all OECD countries and a standard deviation of 100. An increase of 75 points in the PISA reading, mathematics or science scores represents an improvement of about one proficiency level in the specific subject. Approximately two-thirds of OECD participant students scored between 400 and 600 (i.e. within one standard deviation of the average). Due to changes in performance over time, the OECD average scores for mathematics and science in PISA 2009 differ slightly from 500.

Study methods

Thirteen individual study methods were presented in random order to PISA participants in a questionnaire. Students were asked to identify which methods they used 'almost never,' 'sometimes', 'often' or 'almost always' when studying. These 13 individual study methods have been organised by the OECD into three groups of study strategies, with each group reflecting a specific overarching approach to studying. The three grouped study approaches are "memorization strategies," "elaboration strategies" and "control strategies" (see Box 2).

Memorization strategies rely heavily on trying to memorize, in detail, material that has been presented in the classroom or in textbooks. Understanding the material is less important than recitation of the material. Elaboration strategies reflect study methods that position specific school subject matter in the broader context of other school material or on aspects of the student's personal life. Control strategies reflect an approach that endeavours to develop a deep and long-term understanding of the material, including identification of pertinent and important concepts.

Box 2:
PISA grouped study strategies

Memorization strategies
I try to memorize everything that is covered in the text.
I try to memorize as many details as possible.
I read the text so many times that I can recite it.
I read the text over and over again.

Elaboration strategies
I try to relate new information to prior knowledge acquired in other subjects.
I figure out how the information might be useful outside school.
I try to understand the material better by relating it to my own experiences.
I figure out how the text information fits in with what happens in real life.

Control strategies
I make sure that I remember the most important points in the text.
I try to figure out which concepts I still haven't really understood.
I check if I understand what I have read.
When I don't understand something, I look for additional information to clarify this.
I start by figuring out what exactly I need to learn.

Each of the three grouped study strategies is associated with an index. Scores for each index indicate how much of the difference in PISA scores can be explained by the specific overarching approach to studying. Analysis of the impact of each set of grouped study strategies on PISA scores indicated that the 'Index of Memorization Strategies' and the 'Index of Elaboration Strategies' did little to help explain differences between students in their average PISA scores. The 'Index of Control Strategies,' on the other hand, explained between 7.6% and 13.4% of the differences in PISA scores, depending on province, figures that are considered to be relatively high for this type of analysis. In addition, the Index of Control Strategies helped explain a greater share of the differences in scores in Canada (at 10.0%) than in the OECD overall (at 8.2%) signaling that these types of approaches to studying may be of more value to Canadian high school students than to students in many other OECD countries (Table 2).

Table 2
Percentage of variation in PISA scores explained by the use of indexed (grouped) study strategies, Canada and provinces, 2009

	Index of Memorization Strategies	Index of Elaboration Strategies	Index of Control Strategies
	percent		
Canada	**0.2**	**0.1**	**10.0**
Newfoundland and Labrador	0.3	0.3	8.5
Prince Edward Island	2.6	0.9	13.4
Nova Scotia	0.2	0.8	8.0
New Brunswick	0.4	0.5	10.1
Quebec	0.2	0.1	7.6
Ontario	0.2	0.2	11.4
Manitoba	0.3	0.0	9.9
Saskatchewan	1.2	0.0	12.9
Alberta	0.1	0.0	7.6
British Columbia	0.2	0.7	11.3
OECD Average	**1.1**	**1.2**	**8.2**

Source: Programme for International Student Assessment, OECD, 2009.

Given the relatively strong relationship between the Index of Control study strategies and PISA scores, the individual elements included in that index were separated in order to identify which specific elements were associated with increases in PISA performance.

Of the five individual study methods included in the Index of Control Strategies, three appear to be highly effective. Each of these three methods is associated with an increase in average scores of about one-half of a PISA proficiency level (37.5 points) or more when comparing those who used the strategy often/almost always relative to those who used it almost never/sometimes.[2] Significant increases in scores with each of these three methods were evident for both female and male 15-year-old students in each of the reading, mathematics and science subject areas.

Specifically, when comparing students who did and did not use "I make sure that I remember the most important points in the text" as a study method, females using this method had scores that were 56 points higher in reading, 49 points higher in mathematics and 53 points higher in science relative to females who did not use the approach on a regular basis. Males who used this method had scores that were higher by 55 points in reading, 46 points in mathematics, and 49 points in science. This study method was associated with the largest improvements in scores for both males and females of all the study methods explored in PISA.

Average PISA scores were 40 points higher in mathematics for females who regularly used "I try to figure out which concepts I still haven't really understood" when studying, and 42 points higher in reading and science. Average increases in scores for males using this method were 43 points in reading, 40 points in mathematics, and 39 points in science.

When comparing those who used and did not use "I check if I understand what I have read," females who used this approach had scores that were higher by 37 points in reading, 34 points in mathematics, and 36 points in science. Males who habitually used this method had average scores that were 39 points higher in reading and 32 points higher in mathematics and science. (Table 3).

Table 3
Increases in average PISA scores associated with using (often or always) specific control strategies, by selected school subjects and by sex, Canada, 2009

Control strategy	Increase in average score					
	Reading		Mathematics		Science	
	Females	Males	Females	Males	Females	Males
	number					
I make sure that I remember the most important points in the text						
Difference in average scores[1]	56*	55*	49*	46*	53*	49*
I try to figure out which concepts I still haven't really understood						
Difference in average scores[1]	42*	43*	40*	40*	42*	39*
I check if I understand what I have read						
Difference in average scores[1]	37*	39*	34*	32*	36*	32*
When I don't understand something I look for additional information to clarify						
Difference in average scores[1]	31*	35*	28*	31*	29*	31*
I start by figuring out exactly what I need to learn						
Difference in average scores[1]	28*	32*	20*	28*	25*	27*

1 Increase in average score = (the average score for those who use the strategy often/almost always) minus (the average score for those who use the strategy almost never/sometimes)
***** indicates a significant difference in average PISA scores between those who used the strategy almost never/sometimes and those who used it often/almost always, within the same sex.
Source:Programme for International Student Assessment, OECD, 2009.

Additional analysis compared average PISA scores for those who used none or only one of the top three control study methods relative to those who used two or more of them while studying. In all subject areas, and for both females and males, significantly higher scores were associated with study methods that included two or more of the top three elements listed under control strategies. The only exception was for males in reading, where the difference in scores was not statistically significant (Table 4).

Table 4
Average PISA scores associated with the use of the top three control study strategies, by selected school subjects and by sex, Canada, 2009

Subject area	Use of top three control study strategies		Difference in average score
	Used none or only one	Used two or more, often or almost always	
	average PISA score		number
Both sexes			
Reading	485	541	56*
Mathematics	497	540	43*
Science	497	542	45*
Females			
Reading	503	554	51*
Mathematics	486	532	46*
Science	489	538	49*
Males			
Reading	474	526	52
Mathematics	504	549	45*
Science	503	548	45*

***** indicates a significant difference in PISA scores between those who use none or only one of the top three control study methods compared to those who use two or more of the top three control study methods, within the same sex.
Source:Programme for International Student Assessment, OECD, 2009.

When time and effective study strategies are combined

The previous sections have demonstrated how both the time invested in studying and the methods used when studying can each make a difference to performance for female and male students. The following discussion links time and study methods together for an overall examination of the study habits of 15-year-old students as reported in PISA 2009. Linking time investments and study methods produces the following continuum of study habits:[3]

1. **Weak study habits:** student studies less than three hours per week in the designated subject area and uses none or only one of the top three control strategies.

2. **Moderate study habits:** student studies less than three hours per week in the designated subject area and uses two or more of the top three control strategies.
3. **Strong study habits:** student studies three hours or more per week in the designated subject area and uses two or more of the top three control strategies.

In all subject areas and for both sexes, those who indicated that they had weak study habits had the lowest scores in reading, mathematics and science. This was true for all provinces. Generally, as study habits became stronger, PISA scores increased.

For females, average PISA scores in reading increased from 502 for those with weak study habits, to 550 for those with moderate study habits, to 570 for those with strong study habits. Improving study habits in mathematics were associated with increases from 484 to 525 to 547 for female students. Average PISA scores in science also increased for females as study habits improved. The average PISA score in science for females with weak study habits was 489. For females using moderate study habits the average science score was 534 and for those with strong study habits it was 555.

Similar patterns were evident for male students. The average reading score for males with weak study habits was 476, which improved to 528 and 521 for those with moderate or strong study habits, respectively. Males had increases in average mathematics scores from 504, to 548 to 556 across the weak, moderate and strong study habit continuum. Comparable figures in science for male students were 504, 547 and 554. It is worth noting that the difference in average score between females and males with weak study habits in science (15 points) does not exist for females and males with strong study habits (see Appendix Table 1.1 for reading, Table 1.2 for mathematics, and Table 1.3 for science).

A provincial perspective on study habits

The use of either moderate or strong study habits was associated with a significant improvement in average scores relative to those using weak study habits. This was true in all provinces, for both female and male students and across all three subject areas. However, it was not always true that strong study habits were tied to the largest improvement in scores.

Female students who used moderate study habits had significant increases in scores relative to females with weak study habits that ranged from 31 points in mathematics in Manitoba to 54 points in reading in Prince Edward Island, Saskatchewan and British Columbia. The only instance of a non-significant difference for females with moderate study habits compared to those with weak study habits was in mathematics in Newfoundland and Labrador.

With very few exceptions, females with strong study habits had the highest average PISA scores in reading, mathematics and science. Exceptions to this were evident in Newfoundland and Labrador and Quebec in reading, Prince Edward Island in mathematics, and Nova Scotia and Manitoba in science where those using moderate study habits and those using strong study habits had relatively equivalent increases in scores when compared to those with weak study skills. In Saskatchewan in reading and science, females using moderate study habits showed greater improvements in scores than those using strong study habits when compared to those with weak study habits.

The use of strong study habits by females was often associated with a difference of almost a full PISA level in average scores (greater than 60 points) when compared to females with weak study habits. This was the case for reading for female students in Prince Edward Island, Ontario, Manitoba, Alberta and British Columbia. In mathematics, a similarly large impact was evident for females in Quebec, Ontario, Manitoba, and British Columbia. The same was true for females in science in Prince Edward Island, Ontario, Alberta and British Columbia.

For males, the results were much more varied. In reading, moderate study habits were associated with larger improvements in PISA scores than strong study habits in all provinces except New Brunswick and Manitoba. On the other hand, PISA mathematics scores showed the greatest improvements when male students used strong study habits in all provinces except Newfoundland and Labrador, Prince Edward Island and Alberta. Moderate study habits were again most effective for males in science in all provinces except Nova Scotia, Quebec and Ontario.

In several instances for males as well, the increase in PISA scores associated with moderate or strong study habits was equivalent to almost a full PISA proficiency level. The use of moderate study habits by males in reading in Manitoba improved scores by 62 PISA points on average. Strong study habits were linked to similarly large increases for male students in reading in New Brunswick and Manitoba, in mathematics in Nova Scotia and Manitoba, and in science in Nova Scotia (see Table 5.1 for reading, Table 5.2 for mathematics, and Table 5.3 for science).

Table 5.1
Increases in average PISA reading scores when comparing study habits, by sex, Canada and provinces, 2009

	Increase in average reading scores			
	Moderate study habits versus weak study habits		Strong study habits versus weak study habits	
	Females	Males	Females	Males
	number			
Canada	**49** *	**51** *	**68** *	**45** *
Newfoundland and Labrador	34 *	57 *	37 *	30 *
Prince Edward Island	54 *	59 *	64 *	55 *
Nova Scotia	38 *	41 *	44 *	36 *
New Brunswick	43 *	52 *	52 *	63 *
Quebec	42 *	41 *	40 *	21 *
Ontario	52 *	52 *	72 *	48 *
Manitoba	47 *	62 *	69 *	68 *
Saskatchewan	54 *	55 *	45 *	30 *
Alberta	50 *	55 *	75 *	45 *
British Columbia	54 *	58 *	73 *	44 *

* indicates a significant difference in PISA scores for those using the identified study habits compared to those using weak study habits, within each sex.
Source:Programme for International Student Assessment, OECD, 2009.

Table 5.2
Increases in average PISA mathematics scores when comparing study habits, by sex, Canada and provinces, 2009

	Increase in average mathematics scores			
	Moderate study habits versus weak study habits		Strong study habits versus weak study habits	
	Females	Males	Females	Males

	number			
Canada	**41** *	**43** *	**63** *	**52** *
Newfoundland and Labrador	29	46 *	39 *	28
Prince Edward Island	47 *	50 *	49 *	30
Nova Scotia	38 *	36 *	45 *	60 *
New Brunswick	43 *	44 *	51 *	47 *
Quebec	37 *	35 *	66 *	53 *
Ontario	42 *	47 *	66 *	56 *
Manitoba	31 *	38 *	60 *	61 *
Saskatchewan	46 *	34 *	49 *	40
Alberta	34 *	50 *	47 *	48 *
British Columbia	48 *	44 *	67 *	47 *

* indicates a significant difference in PISA scores for those using the identified study habits compared to those using weak study habits, within each sex.
Source:Programme for International Student Assessment, OECD, 2009.

Table 5.3
Increases in average PISA science scores when comparing study habits, by sex, Canada and provinces, 2009

	Increase in average science scores			
	Moderate study habits versus weak study habits		Strong study habits versus weak study habits	
	Females	Males	Females	Males
	number			
Canada	**45** *	**43** *	**66** *	**50** *
Newfoundland and Labrador	32 *	56 *	41 *	46 *
Prince Edward Island	53 *	55 *	67 *	46 *
Nova Scotia	43 *	43 *	43 *	61 *
New Brunswick	40 *	47 *	48 *	21 *
Quebec	42 *	33 *	57 *	48 *
Ontario	48 *	44 *	71 *	55 *
Manitoba	43 *	51 *	45 *	47 *
Saskatchewan	51 *	45 *	42 *	11
Alberta	41 *	48 *	65 *	47 *
British Columbia	47 *	51 *	61 *	39 *

* indicates a significant difference in PISA scores for those using the identified study habits compared to those using weak study habits, within each sex.
Source:Programme for International Student Assessment, OECD, 2009.

PISA results demonstrate that 15-year-old female and male students who used moderate or strong study habits rather than weak study habits had average PISA scores in reading, mathematics and science that were significantly higher than those who used weaker study habits. Nevertheless, while the majority of students reported that they used moderate or strong study habits in 2009, about one in five female students and about one in three male students in every province indicated that they were using weak approaches to studying, regardless of subject area. In all provinces, as well, a significantly higher proportion of males relative to females indicated that they had weak study habits in 2009. The only exception was in British Columbia in reading where the proportions of females and males using weak study habits were not significantly different (Table 6).

Table 6
Proportion of students indicating they were using weak study habits, by selected school subjects and by sex, Canada and provinces, 2009

	Weak study habits in reading		Weak study habits in mathematics		Weak study habits in science	
	Females	Males	Females	Males	Females	Males
	percent					
Canada	**19.4**	**30.5** *	**18.2**	**29.4** *	**19.1**	**30.5** *
Newfoundland and Labrador	21.6	33.3 *	19.8	31.4 *	20.7	32.0 *
Prince Edward Island	23.0	39.6 *	23.0	39.5 *	22.6	40.5 *
Nova Scotia	21.4	37.8 *	20.4	36.7 *	21.1	36.4 *
New Brunswick	24.4	35.0 *	23.1	34.0 *	23.1	35.0 *
Quebec	18.6	32.0 *	16.8	30.8 *	18.4	32.4 *
Ontario	18.0	28.6 *	17.2	27.5 *	17.9	28.1 *
Manitoba	23.9	37.9 *	22.1	36.6 *	23.7	38.0 *
Saskatchewan	23.3	35.4 *	22.6	34.7 *	23.8	36.2 *
Alberta	20.4	29.9 *	18.5	28.5 *	19.8	30.2 *
British Columbia	21.1	28.4	19.6	27.4 *	19.7	28.7 *

* indicates a significant difference between the proportion of females relative to the proportion of males using weak study habits within each province, by school subject area.
Source:Programme for International Student Assessment, OECD, 2009.

Conclusion

The analysis presented in this article demonstrates that both the time invested in studying and the manner in which that time is used are associated with significant differences in the academic performance of 15-year-old students in reading (language arts), mathematics and science.

While investing more than three hours of study per week in each subject area was associated with an improvement in PISA scores, specific study methods were tied to larger improvements. In particular, three methods of studying were found to be linked to increases in average scores of about

one-half (37.5 points) or more of one PISA proficiency level. These were: 1) when studying I try to remember the most important points in the text, 2) when studying I try to figure out which concepts I still haven't really understood, and 3) when studying I check if I understand what I have read. When female and male students used two or more of these three most effective study methods, the associated improvement in average scores was consistently greater than 43 points on the PISA scale.

Both female and male students with weak study habits, that is, they did not make the greater time investment and did not use a combination of the most effective study methods, had the lowest PISA scores in reading, mathematics and science. Those who did not make the time investment but used at least two of the top three control study methods (moderate study habits) or who made the greater time investment and used at least two of the most effective study methods (strong study habits) had PISA scores that were significantly higher in all three subject areas. In several cases the improvement in PISA scores associated with the use of moderate or strong study habits relative to weak study habits was greater than 60 points or almost a full PISA proficiency level.

Although the majority of Canadian students aged 15 in 2009 indicated that they had moderate or strong study habits, there is clearly an opportunity for improvement in the proportion of students who use effective study habits. About one-quarter of the 15-year-old student population in Canada in 2009 spent less than three hours per week studying or doing homework in each of reading (language arts), mathematics and science. And when they did study, they were not using the most effective approaches to studying. Guidance for these 15-year-old students on effective study methods and how much time is appropriate when studying and doing homework may help improve the academic performance of this group of students.

Appendix

Appendix Table 1.1
Average PISA reading scores associated with different study habits, by sex, Canada and provinces, 2009

	Weak study habits		Moderate study habits		Strong study habits	
	Females	Males	Females	Males	Females	Males
	average score					
Canada	**502**	**476**	**550**	**528**	**570**	**521**
Newfoundland and Labrador	503	450	537	507	540	480
Prince Edward Island	472	434	526	493	536	489
Nova Scotia	503	482	541	522	547	517
New Brunswick	482	451	525	502	534	514
Quebec	506	482	548	524	546	504
Ontario	504	481	555	533	576	529
Manitoba	476	445	523	507	545	513
Saskatchewan	487	460	541	514	531	489
Alberta	508	484	558	538	584	529
British Columbia	499	472	553	530	573	516

Source: Programme for International Student Assessment, OECD, 2009.

Appendix Table 1.2
Average PISA mathematics scores associated with different study habits, by sex, Canada and provinces, 2009

	Weak study habits		Moderate study habits		Strong study habits	
	Females	Males	Females	Males	Females	Males
	average score					
Canada	**484**	**504**	**525**	**548**	**547**	**556**
Newfoundland and Labrador	479	479	509	525	518	507
Prince Edward Island	454	468	501	518	503	497
Nova Scotia	475	499	513	536	520	559
New Brunswick	462	485	506	529	513	532
Quebec	501	528	538	563	566	581
Ontario	482	497	524	544	548	553
Manitoba	469	483	500	522	529	544
Saskatchewan	470	490	515	524	518	530
Alberta	493	505	527	555	540	553
British Columbia	474	503	522	547	541	551

Source: Programme for International Student Assessment, OECD, 2009.

Appendix Table 1.3
Average PISA science scores associated with different study habits, by sex, Canada and provinces, 2009

	Weak study habits		Moderate study habits		Strong study habits	
	Females	Males	Females	Males	Females	Males
	average score					
Canada	**489**	**504**	**534**	**547**	**555**	**554**
Newfoundland and Labrador	496	482	528	538	537	528
Prince Edward Island	460	467	513	522	527	514
Nova Scotia	489	503	532	546	532	564
New Brunswick	466	479	506	526	515	500
Quebec	486	509	529	542	543	556
Ontario	488	503	536	547	558	559
Manitoba	473	483	516	534	519	530

Saskatchewan	477	495	528	540	519	506
Alberta	508	517	548	565	572	564
British Columbia	496	505	543	557	556	544
Source: Programme for International Student Assessment, OECD, 2009.						

Notes

1. Referred to as 'language arts' in the PISA student questionnaire.
2. Individual elements in the Memorization group of strategies and in the Elaboration group of strategies were associated with increases of 20 points or less in all subject areas for both females and males.
3. A fourth category, "studies three hours or more per week and uses none or only one of the top three control strategies," would complete the exhaustive list of study habits. However, less than 5% of students indicated that they followed this approach to studying. As a result of the low counts for this category, scores and distributions were either unreliable or too small to be published. Therefore, this category has been eliminated from the ensuing discussions.